Does cash flow volatility affect firm capital structure? [1]

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Abstract

The empirical literature on the relationship between capital structure and firm cash flow volatility is inconclusive. Using a conditional cash flow volatility measure along with considering the fact that proportional capital structure measures have nonlinear relationships with explanatory factors, we find firms with high cash flow volatility (i) use less debt, (ii) are more likely to use zero debt, and (iii) use shorter maturity debt.

Keywords: Capital structure, cash flow volatility, zero leverage, debt maturity

JEL Classification Codes: G32—Financing Policy,

1 Introduction

In their seminal paper, Frank and Goyal (2009) investigate twenty five explanatory variables affecting capital structure and find six robust factors[2] that reliably explain firm capital structure.[3] Frank and Goyal (2009) do not find cash flow volatility robustly explains capital structure. However, contrary to their findings, theory suggests that cash flow volatility affects capital structure. Black and Scholes (1973), Merton (1974), Bradley, Jarrell and Kim (1984) develop theories which advance that cash flow volatility affects capital structure. In this paper, we investigate the effect of cash flow volatility on capital structure levels.

In contrast to Frank and Goyal (2009), we find that cash flow volatility has a significant negative effect on a firm's capital structure. Our result could derive from two main differences. First, Frank and Goyal (2009) use annual variance of asset returns as volatility measure. In contrast, we use a conditional cash flow volatility measure developed by De Veirman and Levin (2011). Second, Frank and Goyal (2009) use a linear regression to find the reliable factors. In contrast, we consider the fact that our dependent variable (debt ratio) is a proportion variable and the conditional expectation is a nonlinear function of the independent variables (Papke and Wooldridge, 1996), (Cox, 1996), (Paolino, 2001), (Kieschnick and McCullough, 2003), and (Cook, Kieschnick and McCullough, 2008). By using a linear prediction of proportion variable which is strictly bounded between zero and one, some specification errors may occur (Cook et al., 2008). Therefore, in analysing our dependent proportion variable, we use a generalized linear model (GLM) with logit link function to alleviate the linearity problem accompanied by the proportion dependent variable. Furthermore, our negative significant relationship between cash flow volatility and capital structure is consistent with some empirical studies like Bradley et al. (1984) and Kim and Sorensen (1986) and on the contrary to Friend and Lang (1988) who find a significant positive relationship between volatility[4] and capital structure.

[2]These factors include median industry leverage, market to book ratio (a proxy for growth opportunity), assets tangibility, firm size (log of assets), profitability and expected inflation.

[3]Frank and Goyal (2009) paper has been cited in 738 researches since 2009.

[4]Bradley et al. (1984), Kim and Sorensen (1986) and Friend and Lang (1988) use variability of firm value, standard deviation of earnings and variation in earnings before interest and taxes as volatility measure, respectively.

Our second result provides insight into the zero leverage policy. In their paper "the mystery of zero-leverage firms", Strebulaev and Yang (2013) find that the probability of zero leverage policy decreases with earning volatility. Strebulaev and Yang (2013) use a logit regression on 1) the entire sample, 2) sub sample of dividend-paying firms and 3) subsample of zero-dividend firms. They find negative and significant volatility coefficients using the all firms and zero-dividend sub samples, and positive and significant coefficient using the dividend-paying sub sample. We investigate this mystery and in contrast to Strebulaev and Yang (2013), we find that firms with high cash flow volatility are more likely to follow zero leverage policy. We believe that the different result is due to Strebulaev and Yang (2013) earning volatility measure. They use a rolling volatility measure which calculates profitability volatility for the past ten years.

Our third result shows the relationship between cash flow volatility and debt maturity. We find that as cash flow volatility increases, the probability that a firm holds longer maturity debt decreases. This is consistent with Kane, Marcus and McDonald (1985) and Stohs and Mauer (1996) who find an inverse relationship between debt maturity and volatility of firm asset value. Our third result contribution to the existing finance literature is due to following reasons; first, we use a conditional cash flow volatility measure not volatility of firm asset value. Second, our categorical maturity debt measure is not a maturity structure measure, in fact it measures the existence of zero-leverage at different maturity.

Moreover, we conduct some additional tests to check the robustness of our results. We perform our robustness check for the first two results that are different with the existing literature. For the first hypothesis robustness check, we add the lag of dependent variable to the explanatory factors. Although the coefficients of the lagged dependent variable are highly economically and statistically significant, we still get negative and statistically significant correlation between cash flow volatility and capital structure. For the second hypothesis robustness check, we follow Strebulaev and Yang (2013) and generate three sub-samples. Our result shows that in each of the three sub-samples, firms with high cash flow volatility are more likely to follow zero leverage policy which is consistent with our main finding. All in all, our conclusions about the effects of cash flow volatility on capital structure and zero-debt policy are robust to existence of the lagged dependent variable in the explanatory factors set, and changes in the sample and zero-leverage definition.

This paper proceeds as follow, Section 2 reviews the literature and develop our hypotheses of the study. Section 3 reviews the data, constructs the variables and report the univariate statistics of the variables. Section 4 tests the hypotheses and discusses the results. Section 5 performs some robustness check and reports and compares the robustness results with the reports results in Section 4. Section 6 provides concluding remarks.

2 Literature review and hypothesis development

Black and Scholes (1973) price a European call option as

$$Call_{BS}(V_t, B, r, T-t, \sigma) = V_t N(d_1) - Be^{-r(T-t)} N(d_2), \tag{1}$$

where V_t is value of underlying assets, B is strike price, r is annual risk free rate, $T-t$ is time in years to expiration date, σ is volatility, and

$$d_1 = \frac{[ln\,(V_t/B) + (r + \sigma/2)(T-t)]}{\sqrt{\sigma(T-t)}}$$

and

$$d_2 = d_1 - \sqrt{\sigma(T-t)}, \tag{2}$$

where $N(d)$ is cumulative standard normal distribution.[5]

Stoll (1969) shows the relationship between the price of a European call option and a European put option with identical strike price and expiry date as

$$Put_{BS}(V_t, B, r, T-t, \sigma) = Be^{-r(T-t)} - V_t + Call_{BS}(V_t, B, r, T-t, \sigma). \tag{3}$$

[5] We use notation of Sundaresan (2013). See Sundaresan (2013) for a literature review of extensions of Merton's model.

The relationship shown in Equation (3) is called put-call parity. Equations (1) and (3) imply that price of call and put options increase with volatility σ.[6]

Black and Scholes (1973) and Merton (1973) recognize that the option pricing model could be applied to develop a model to price the corporate equity and liabilities in general. By following the option pricing model, Merton (1974) develops a model to price the debt and equity of the firm. In Merton's model, equity holders own the firm V_T and borrow debt at $t = 0$ from debt holders (creditors) with face value B payable at T. Due to the limited liability, in the case of default at T when $B \geq V_T$, creditors receive V_T. Otherwise, creditors receive B. Therefore, the uncertain payoff to the creditors is

$$D(V_T, T) = min(V_T, B). \tag{4}$$

By employing Black and Scholes (1973) formula, Merton (1974) expresses value of the firm as

$$FirmValue = Call_{BS}(V_t, B, r, T-t, \sigma) + Be^{-r(T-t)} - Put_{BS}(V_t, B, r, T-t, \sigma), \tag{5}$$

where the value of equity is

$$E(V_t, t) = Call_{BS}(V_t, B, r, T-t, \sigma), \tag{6}$$

and the value of debt is

$$D(V_t, t) = Be^{-r(T-t)} - Put_{BS}(V_t, B, r, T-t, \sigma). \tag{7}$$

Equation (6) shows that the value of the equity of a levered firm is equivalent to a call option on the assets of the borrowing firm. Equation (7) shows that the value of the debt is equal to the value of risk-free debt minus a put option value. Because cash flow volatility increases the value of call and put options, higher cash flow volatility increases equity value in Equation (6), while it decreases debt value in Equation (7), which in term increases the marginal cost of debt. The cost

[6] $\nu = \frac{\partial Call_{BS}}{\partial \sigma} > 0$, measures the sensitivity of a call option to volatility.

of debt is

$$R_D = \frac{B}{D(V_t, t)} - 1. \tag{8}$$

Because an increase in σ decreases $D(V_t, t)$, an increase in σ also increases R_D. This insight in combination with the Kraus and Litzenberger (1973) trade-off theory implies that high cash flow volatility firms use less debt, which leads to the following hypothesis.

Hypothesis 1. *Firms with high cash flow volatility use less debt.*

The application of Black and Scholes (1973) model to firm capital structure implies that the cost of debt increases with cash flow volatility. At very high levels cash flow volatility, the cost of debt maybe sufficiently high to make the zero-debt policy the optimal decision, implying:

Hypothesis 2. *The probability of a firm uses zero debt increases with cash flow volatility.*

Another application of Black and Scholes (1973) model to firm capital structure implies that the cost of debt increase with debt maturity. The value of debt is shown in Equation (7). The first term is the present value of the strike price, which decreases with time to maturity. The second term is the value of a put option, which increases with time to maturity. As a result the value of debt in Equation (7) decreases with time to maturity. The marginal cost of debt is shown in Equation (8). Because an increase in $(T-t)$ decreases $D(V_t, t)$, an increase in $(T-t)$ also increases R_D (the cost of debt). We develop the following hypothesis based on debt maturity.[7]

Hypothesis 3. *The probability of a firm uses long (short) maturity debt decreases (increases) with cash flow volatility.*

3 Sample, variable construction, and univariate statistics

3.1 Sample

We obtain annual data from 1974 through 2012 of US corporations from the Compustat CRSP Merged database. Following Frank and Goyal (2009), we exclude financial firms and firms involved

[7] For more debt maturity literature review, you can refer to Stohs and Mauer (1996).

in major mergers (Compustat footnote code AB)[8] and firms with missing book value of assets. We also exclude firms with zero and negative common shareholders' interest in the company, utility firms, firms with negative total assets and negative total revenue and firms with missing revenue and total assets value.

We check Compustat' s debt items[9] for consistency. Compustat defines debentures (item *dd*) as long-term debt which matures in more than ten years after issuance. To construct the data set, we replace missing *dd* with zero if long-term debt item of Compustat *dltt* and long-term debt due in one year $dd1$[10] is zero ($dltt + dd1 = 0$). Then, we drop the firm-year observations with missing debentures. We also replace missing total liabilities *lt* with zero if *dltt* and *dlc* are zero, and drop the remaining missing *lt*. In addition, due to the existence of missing firm-year observations for items dd_i[11] for i= 2 to 5; we decide not to use these items to construct maturity debt variable.

Following Kale and Shahrur (2007), we winsorize the data at the 1% level in both tails of the distribution. After variable filtrations the sample includes 123,258 firm-year observations from 1974-2012.

3.2 Variable Construction

3.2.1 Capital Structure Measures

Welch (2011, page 2) states,

> There is no universally used measure of leverage. Most researchers probably spend little time pondering their measure and simply copy what their predecessors have adopted. An informal census of the recent literature suggests that about half of all recently

[8] Compustat assigns a footnote AB to total sales (*revt*) and create variable *revt_fn*, if sales increase by more than 50 percent in response to a merger or an asset acquisition.

[9] We use Compustat items *dd*, *dn*, *dltt*, *dlc* and *dclo* to construct one of our study variable in Section 3.2. Compustat defines: *dd* as debt-debentures, which represents long-term debt containing a promise to pay a specific amount of money on a fixed date usually more than 10 years after issuance and a promise to pay interest on stated dates; *dn* as debt-notes, which represents long-term debt possibly secured by the pledge of property or securities owned by the company; *dltt* as total long-term debt, which represents debt obligations due more than one year from the company's balance sheet date; *dlc* as total debt in current liabilities, which represents the total amount of short-term notes and the current portion of long-term debt (debt due in one year); and *dclo* as debt-capitalized lease obligations, which represents the debt obligation a company incurs when capitalizing leases. The major difference between notes and bonds is that notes have shorter maturities.

[10] Note that $dd1$ is not a component of *dltt* and it is a component of debt in current liability *dlc*.

[11] dd_i for i= 2 to 5 represents debt that matures in year i.

published papers have defined leverage as financial-debt divided by assets (FD/AT). Unfortunately, this measure is incorrect.

The financial-debt-to-asset ratio (FD/AT), implicitly treats non-financial liabilities as equity, which is clearly wrong.

Kieschnick, Keefe and Cook (2013) review thirteen book and market capital structure measures used by prior studies including Bradley et al. (1984), Frank and Goyal (2009), Rajan and Zingales (1995), Welch (2011) and Fama and French (2002). Kieschnick et al. (2013) evaluates these capital structure measures using the Welch (2011) critique and find the explanatory variables robustness is sensitive to the capital structure measures chosen.

Broadly speaking there are two questions regarding capital structure ratios. First, "what liabilities should be included in debt?" We define debt using three categories. Most broadly, debt consists of all liabilities includes non-financial liabilities. Most narrowly, debt consists of only long-term debt. Lastly, debt consists of both short-term and long-term debt but not non-financial liabilities. Thus, the capital structure may be defined in three ways. The second question is "should debt measured using book or market value?" Keeping in mind the Welch (2011) critique and taken together the three measures of capital structure for both market and book values generates six capital structure variable. We construct our six measures of capital structure measures below.

The broadest definition of debt includes all liabilities in the numerator. The Compustat item total liabilities (lt) includes the non-financial liabilities. To construct the all liabilities market debt ratio, we follow Rajan and Zingales (1995) and Welch (2007). The numerator is total liabilities and the denominator is total assets minus common shareholders equity plus market value of common stock. We define the all liabilities market debt ratio as

$$MDR1 = \frac{lt}{(at - ceq) + csho * prcc\_f}. \tag{9}$$

Rajan and Zingales (1995) and Welch (2011) define the all liabilities book debt ratio as the total liabilities in the numerator and total assets in the denominator. We construct the all liabilities book debt ratio as

$$BDR1 = \frac{lt}{at}. \tag{10}$$

Both $MDR1$ and $BDR1$ categorize non-financial liabilities as debt.

The second category defines the capital structure measures by short-term plus long-term debt in the numerator. Rajan and Zingales (1995) construct the short and long-term market debt ratio as the long plus short-term debt over short and long-term debt plus the market value of equity. We define the short-term plus long-term market debt ratio as

$$MDR2 = \frac{dltt + dlc}{dltt + dlc + csho * prcc\_f}. \tag{11}$$

To construct the short and long-term book debt ratio we follow Rajan and Zingales (1995). The numerator of this measure is the short plus long-term debt and the denominator is short plus long-term debt plus common shareholder equity. We define the short-term plus long-term book debt ratio as

$$BDR2 = \frac{dltt + dlc}{dltt + dlc + ceq}. \tag{12}$$

Both $MDR2$ and $BDR2$ are consistent with the Welch (2011) critique as the denominators exclude the non-financial liabilities.

The most narrow definition of debt includes only long-term debt in the numerator of capital structure measures. We follow Bradley et al. (1984) and define the long-term market debt ratio as the total long-term debt over the total long-term debt plus market value of equity. We define the long-term market debt ratio as

$$MDR3 = \frac{dltt}{dltt + csho * prcc\_f}. \tag{13}$$

To measure the long-term book debt ratio, we construct a long-term book debt ratio as total long-term debt divided by the total long-term debt plus common share holder equity. We define the long-term book debt ratio as

$$BDR3 = \frac{dltt}{dltt + ceq}. \tag{14}$$

Both $MDR3$ and $BDR3$ are consistent with the Welch (2011) critique as the denominators exclude the non-financial liabilities.

To test Hypothesis 2, we construct two zero leverage variables. There are two important considerations in the construction of zero leverage measure. First, the determination of whether a firm has zero leverage is unrelated to whether the capital structure measured using market or book value. Second, because all firms hold non-financial liabilities, we do not consider $MDR1$ and $BDR1$ for measuring zero leverage. Based on these considerations, we construct two measures of zero leverage.

We follow Strebulaev and Yang (2013) and Lee and Moon (2011) and construct the dummy variable $ZeroLSD$ which is set to one if long-term plus short-term debt is zero and zero, otherwise. Under this definition $ZeroLSD$ equals one if either the numerators of $MDR2$ or $BDR2$ are zero. $ZeroLTD$ is a dummy variable set to one if long-term debt equals zero and zero, otherwise. With this definition $ZeroLTD$ is one if the numerators of either $MDR3$ or $BDR3$ are zero.

To test Hypothesis 3, we construct an ordered categorical variable based on use of debt at different maturity. The first category includes firms that hold debt with more than ten years of maturity, and the last category includes firms with no long and short-term debt. We construct $OrderedMaturityD$ using Compustat items[12] as follows:

i) $OrderedMaturityD = 1$ if a firm's debt that matures in more than ten years is not zero, where $dd \neq 0$.

ii) $OrderedMaturityD = 2$ if a firm has debt that matures in less than ten years, and has no debt that matures in ten or more years, where $dd = 0$, $dn \neq 0$ and $dltt \neq 0$.

iii) $OrderedMaturityD = 3$ if a firm has no debt that matures in five or more years, where $dd = 0$, $dn = 0$ and $dltt \neq 0$.

iv) $OrderedMaturityD = 4$ if a firm's total long-term debt is zero, where $dltt = 0$ and $dd = 0$.

v) $OrderedMaturityD = 5$ if a firm has zero long-term and short-term debt, where $dltt = 0$, $dlc = 0$, $dn = 0$, $dd = 0$, $dclo = 0$.

[12]We define the Compustat items in Footnote 9.

3.2.2 Control Variables

To test our hypotheses, we use the Frank and Goyal (2009) most reliable factors as controls to explain a firm debt ratio and construct:

i) $MarketToBook$ is the ratio of market value of assets to total assets (proxy of growth opportunities).

ii) $IndustLev$ is the median industry leverage and is the median of total debt to market value of assets by year and four-digit SIC code.

iii) $Tang$ is the asset tangibility. It is the ratio of fixed assets-to-total assets.

iv) $FirmSize$ is a proxy for firms' size. It is the natural log of the total assets of the firm.

v) $Profitability$ shows the profitability of a firm and is the ratio of the firm operating income before depreciation to total assets.

vi) $ExpectedInflation$ is the expected change in the consumer price index over the coming year.

We also construct five additional explanatory variables.

vii) $LnRnD$ is the natural logarithm of (1+ the ratio of R&D expenses to sale) (Frank and Goyal, 2009).

viii) $NetEquityIssuance$ is the net equity issuance of a firm (Lemmon, Roberts and Zender, 2008).

ix) $CreditRating$ is a dummy variable. It is equal to one if S&P rates the debt as the investment grade debt and is equal to zero if the firm is rated less than investment grade (Frank and Goyal, 2009).

x) $FirmAge$ computed as the number of years a firm has been listed in the Compustat (Bergstresser and Philippon, 2006).

3.2.3 Key Variable of Interest

The key variable of interest in this study is cash flow volatility. Most of the studies in corporate finance use "rolling methods" as a proxy for current volatility.[13] By construction these rolling volatility measures do not explain volatility at a point in time. We employ the conditional cash flow volatility measure developed by De Veirman and Levin (2011) used by De Veirman and Levin (2012) and Keefe and Tate (2013).

To construct the cash flow volatility measure, first we estimate

$$\omega_{i,t} = \alpha_i + Year\beta_1 + \epsilon_{i,t} \tag{15}$$

where $\omega_{i,t}$ represents cash flow growth scaled by total assets[14] from $t-1$ to t for firm i and, $Year$ is a matrix of year dummies. After controlling for time, and firm fixed effects, the residual $\epsilon_{i,t}$ shows the deviation of operating cash flow of firm i from its mean value. De Veirman and Levin (2011) show that the conditional cash flow volatility $\hat{\sigma}_{i,t}$ is an unbiased estimator of the true conditional volatility

$$\hat{\sigma}_{i,t} = \sqrt{\pi/2} * |\hat{\epsilon_{i,t}}| \ , \tag{16}$$

where $\hat{\epsilon_{i,t}}$ is the estimated residual from Equation (15).

We estimate $\hat{\sigma}_{i,t}$ using cash flow growth $\omega_{i,t}$ scaled by total assets.[15] We define $LnCFV$ as the natural logarithm of $\hat{\sigma}_{i,t}$ (scaled by assets).

insert Table 2

Table 2 shows that the logarithmic transformation improves the distributional pattern of the cash flow volatility measures. Specifically, the skewness and the kurtosis of CFV are 3.54 and 16.56, respectively, whereas the skewness and the kurtosis of $LnCFV$ are -0.62 and 4.31, respectively.[16]

[13] Kim and Sorensen (1986) employ the coefficient of variation in earnings before interest and taxes (EBIT) measured over 10 years. Dierker, Kang, Lee and Seo (2013) OCF Risk, operating risk, is measured as the annualized standard deviation of 20 recent quarterly operating cash flows divided by total assets over the past five years. Titman and Wessels (1988) use the nine years standard deviation of the percentage change in operating income. Kester (1986) obtain return on assets for the five preceding years.Strebulaev and Yang (2013) use the earning volatility and construct it as the volatility of profitability calculated for the past 10 years.

[14] Total assets is calculated using Compustat item total assets *at* minus cash and short-term investment *che*.

[15] Bradley et al. (1984) and Stohs and Mauer (1996) also use asset scaled volatility.

[16] A normal distribution would have a skewness of 0 and a kurtosis of 3.

3.2.4 Univariate Statistics

insert Table 3

Table 3 reports the summary statistics. The means of the three categories of capital structure measures show that the more broadly we define the debt, the higher market and book debt ratios. The mean of $MDR1$ which includes all liabilities of a firm is greater than the mean of $MDR2$ that includes the long and short-term debt of a firm and the mean $MDR2$ is greater than the mean of $MDR3$ which includes the long-term debt of a firm. For example the mean of $MDR1$ is 0.376, the mean of $MDR2$ is 0.242 and the mean of $MDR3$ is 0.197. Book debt ratios also follow the same pattern. The mean of $BDR1$ is 0.469, the mean of $BDR2$ is 0.297, and the mean of $BDR3$ is 0.242. The mean of $MarketToBook$ is 1.5 which is consistent with smaller market than book debt ratios. The average $FirmAge$ is 10.45 years and the mean of $FirmSize$ is 4.70 million dollars based on total assets. Table 3 also shows that among 13.1% of the sample firm-years, firms hold no short-term debt or long-term debt, while 16.2% hold no long-term debt.

insert Table 4

Table 4 reports categorical variable $OrderedMaturityD$ frequency, percent and cumulative percent. Table 4 shows that in 43.89% of the sample firm-year observations, firms do not use debt that matures in more than ten years. Also the table shows that in 20% of the sample firm-year observations, firms do not use debt that matures in more than five years. Therefore, more than 60% of the firms belongs to categories 2 and 3 of the $OrderedMaturityD$. In addition, Table 4 shows that 13.1 % of the sample firms belong to category 5 which is consistent with Table 3 report on zero long and short-term debt.

insert Table 5

Table 5 reports the correlation coefficients between explanatory variables. Table 5 shows that cash flow volatility measure is negatively correlated with $Profitability$, $IndusLev$, $FirmSize$ and positively correlated with $LnRnD$, and $MarketToBook$. The correlation coefficients between

$LnCFV$ and $FirmSize$, $Profitability$ and $IndustLev$ is -28.6 , -33.0 and -29.5 percent, respectively. On the other hand, the correlation coefficients between $LnCFV$ and $MarketToBook$ is 26.7 percent and $LnRnD$ is 35.1 percent. Overall, highly volatile firms are smaller, less profitable, belong to industries with low levels of debt, have more growth opportunities and spend more on research and development projects.

insert Figure 1

To depict the relationship between cash flow volatility, the market debt ratio and the percentage of firms with zero leverage, we construct 20-quantiles of cash flow volatility. Figure 1 plots $MDR3$ over twenty cash flow volatility quantiles. The plots of other market and book debt ratios are similar to $MDR3$. In Figure 1, $MDR3$ declines slowly from the first quantile to the thirteenth quantile. From quantile 13 to quantile 16, $MDR3$ drops the same amount as in the first thirteen quantiles. Thereafter, from quantile 16, $MDR3$ decreases at rate of change which is approximately three times higher than the first thirteen quantiles. In addition, Figure 1 shows that the percentage of zero leverage firms increases with volatility. Figure 1 shows a non-linear relationship between cash flow volatility and debt ratios.

4 Testing

4.1 Testing Hypothesis 1 - There is a negative relationship between cash flow volatility and leverage.

The evidence produced in Figure 1 suggests a nonlinear relationship between debt ratios and cash flow volatility. Frank and Goyal (2009) do not study potential nonlinearities. Frank and Goyal (2009, page 26) write:

> There are a number of other things that we have not studied in this paper. We have not allowed for alternative functional forms and general nonlinearities. ... All of these are potentially interesting, and we hope to explore many of them in the future.

The dependent variable of this study is a proportion variable bounded between zero and one. Cook et al. (2008) address some common specification errors in using a linear prediction equation to model the proportion or fraction variable and show the conditional expectation is a nonlinear function of the independent variables. Cook et al. (2008) finding is consistent with Papke and Wooldridge (1996), Cox (1996), Paolino (2001), Kieschnick and McCullough (2003). The difficulty in terms of analysing the proportion data is that the responses are strictly bounded. To mitigate the estimation problems causing by nonlinearity and bounded dependent variable, one can use a logistic transformation of the dependent variable. However, the logistic transformation of the dependent variable is not applicable here as our depended variable includes zero and one in lower and the upper bounds. To test our proportional dependent variable which includes zero and one, we follow Papke and Wooldridge (1996) and Baum (2008) and use a generalized linear model (GLM) with logit link function. The logit quasi-maximum likelihood estimate analysis under the GLM framework allows our response variable to have an arbitrary function (link function), rather than normal distribution. GLM also allows this arbitrary function of the response variable to vary linearly with the predicted values (not just the response variable itself).

$$E(DebtRatio_{i,t}|x) = G(\alpha + X_{i,t-1}\beta_1 + \beta_2 LnCFV_{i,t-1}) \tag{17}$$

where

- G(.) is the logistic function,
- $DebtRatio_{i,t}$ is market or book debt ratio, $MDR1$, $MDR2$, $MDR3$, $BDR1$, $BDR2$ and $BDR3$,
- $X_{i,t-1}$ is a matrix of lagged control variables listed in Section 3.2.2, and
- $LnCFV_{i,t-1}$ is $LnCFV$.

insert Table 6

Table 6 shows estimation results of Equation (17) using $LnCFV$ as the variable of interest. Using cluster standard errors by firm the table reports that the coefficients associated with asset scaled cash flow volatility $LnCFV$ are statistically significant in explaining all capital structure measures at the 1% significance level. Columns (1), (3) and (5) show the estimated coefficients using the market debt ratios and Columns (2), (4) and (6) show the estimated coefficients using the book debt ratios. Each coefficient associated with $LnCFV$ is negative, implying that firms with high cash flow volatility use less debt. The reliable factors of Frank and Goyal (2009) are statistically significant.

Our result also reports statistically significant and negative $LLnRnD$ coefficients. This is different from Frank and Goyal (2009) as they do not report research and development expenses as one of the six reliable factors in their study. These negative coefficients indicate that firms with higher research and development spending employ less debt. Overall, the findings support Hypothesis 1 that the firms with more volatile cash flows use less debt. In contrast, Frank and Goyal (2009) do not find that volatility is a reliable factor in explaining capital structure. Our result relative to Frank and Goyal (2009) maybe due to using a different volatility measure. Frank and Goyal (2009) use the variance of stock returns, whereas we use cash flow volatility.

insert Figure 2

Also, Frank and Goyal (2009) employ a linear model in their paper, whereas we use a generalized linear model (GLM) with logit link function. To show how GLM estimates the nonlinear relationship, Figure 2 plots $MDR3hatG$ and $MDR3$ over twenty cash flow volatility quantiles. $MDR3hatG$ is $MDR3$ prediction by generalized linear model (GLM) with logit link function of Equation (17). As shown in the Figure, $MDR3hatG$ is a good prediction of $MDR3$. Using GLM with logit link function, we find that plots of other market and book debt ratios are similar to $MDR3$.

4.2 Testing Hypothesis 2 - The effects of cash flow volatility on zero-leverage policy

To test the effects of cash flow volatility on zero-leverage policy, we use two zero-leverage dummy variables $ZeroLSD$ and $ZeroLTD$ as dependent variables using a probit regression. The probit regression estimates the probability that a firm with specified characteristics (e.g. cash flow volatility) fall into one of the dependent variables' two categories (being zero-leverage or not). We estimate

$$Pr(ZeroL = 1|X) = \Phi(X_{i,t-1}\beta_1 + \beta_2 LnCFV_{i,t-1}), \tag{18}$$

where

- Pr denotes probability,
- $ZeroL$ is the zero-leverage variable, $ZeroLSD$ or $ZeroLTD$,
- Φ is the Cumulative Distribution Function (CDF) of the standard normal distribution,
- $X_{i,t-1}$ is a matrix of lagged control variables listed in Section 3.2.2, and
- $LnCFV_{i,t-1}$ is lag of $LnCFV$.

insert Table 7

Table 7 reports estimation results of Equation 18 using $LnCFV$ as the variable of interest. Columns (1) shows estimation results using the $LnCFV$ as $ZeroLSD$ zero long and short-term debt explanatory variable. Columns (2) shows estimation results using the $LnCFV$ as $ZeroLTD$ zero long-term debt explanatory variable. The coefficients associated with $LnCFV$ are positive and statistically significant; implying that firms with high cash flow volatility are more likely to be zero leverage.

insert Table 8

To show the magnitude of the effect we find the marginal effects.[17] Table 8 reports the marginal effects of $LnCFV$ on zero leverage dependent variables. As discussed in Footnote 17, to find the marginal effects, we use the mean of all explanatory factors $X_{i,t-1}$ along with the mean, the 25th

[17] The marginal effect of an specified explanatory variable in probit model will be calculated as below

$$Pr(ZeroL = 1|X) = \Phi(X_{i,t-1}\beta_1 + \beta_2 LnCFV_{i,t-1}),$$

$$\frac{\partial P}{\partial LnCFV} = \phi(X_{i,t-1}\beta_1 + \beta_2 LnCFV_{i,t-1}) * \beta_2 \tag{19a}$$

where $\phi(X_{i,t-1}\beta_1 + \beta_2 LnCFV_{i,t-1})$ is the standard normal probability density function evaluated at $X_{i,t-1}\beta_1 + \beta_2 LnCFV_{i,t-1}$. It is obvious that this evaluation depends on the particular value of the X variables and $LnCFV$ variable. Here, to find the marginal effect we use the mean of X variables, and the mean, the 25th percentile, and the 75th percentile of our variable of interest $LnCFV$.

percentile, and the 75th percentile of our variable of interest $LnCFV$. Columns (1), (2) and (3) show the marginal effects of $LnCFV$ on dependent variable using the mean, the 25th percentile, and the 75th percentile of our variable of interest $LnCFV$, respectively. Column (1) shows that at the mean of $LnCFV$, one percent standard deviation increase in $LnCFV$ increases the probability of a firm holding no long and short-term debt $ZeroLSD$ by about 0.0126% and increase the probability of a firm holding no long-term debt $ZeroLTD$ by about 0.0151%. Column (2) shows that at the 25th percentile of $LnCFV$, one percent standard deviation increase in $LnCFV$ increases the probability of a firm holding no long and short-term debt $ZeroLSD$ by about 0.0113% and increase the probability of a firm holding no long-term debt $ZeroLTD$ by about 0.0139%. Column (3) shows that at the 75th percentile of $LnCFV$, one percent standard deviation increase in $LnCFV$ increases the probability of a firm holding no long and short-term debt $ZeroLSD$ by about 0.0141% and increase the probability of a firm holding no long-term debt $ZeroLTD$ by about 0.0165% . The largest coefficients belong to the 75th percentile of $LnCFV$. Overall, statistically significant and positive coefficients in Table 8 show that cash flow volatility increases the probability of being zero-leverage.

We find higher cash flow volatility increases the probability of a firm being zero-leverage. This is not consistent with Strebulaev and Yang (2013) findings. Strebulaev and Yang (2013) show that the probability of zero leverage policy decreases with earning volatility. The Black and Scholes (1973) model support the positive cash flow volatility coefficients. Strebulaev and Yang (2013) earning volatility is the volatility of profitability calculated for the past ten years; using a rolling volatility by Strebulaev and Yang (2013) might be the reason that we find a different result.

insert Figure 3

Figure 3 plots $ZeroLSDhat$ and $ZeroLSD$ over twenty cash flow volatility quantiles. $ZeroLSDhat$ is $ZeroLSD$ prediction by probit regression Equation (18). As shown in the Figure, $ZeroLSDhat$ is a good prediction of $ZeroLSD$. Using probit regression for $ZeroLTD$ we find that the plot of $ZeroLTD$ is similar to $ZeroLSD$.

4.3 Testing Hypothesis 3 - The effects of cash flow volatility on maturity of debt.

insert Figure 4

Figure 4 shows the implied cost of debt[18] for different time horizons of debt maturity by the 20-quantiles of cash flow volatility. The graph indicates that as the maturity of the debt increases; the implied cost of debt increases.

To test Hypothesis 3, We use an ordered probit model. By using an ordered probit model we estimate the relationship between cash flow volatility and debt by maturity. We construct $OrderedMaturityD$ in section 3.2.1. The ordering starts from firms that hold debt with more than ten years of maturity to firms with no long and short-term debt. Ordered probit model allows us to test the debt maturity hypothesis for five categories of $OrderedMaturityD$. To model the ordered probit regression, we define an unobserved (latent) index function

$$OrderedMaturityD^* = X_{t-1}\beta_1 + \beta_2 LnCFV_{t-1} + \upsilon_j,$$

$$Pr(OrderedMaturityD_j = i) = Pr(\kappa_{i-1} < OrderedMaturityD^* \leq \kappa_i),$$

$$Pr(OrderedMaturityD > i|\kappa, X_{t-1}, \upsilon_j) = \Phi(X_{t-1}\beta_1 + \beta_2 LnCFV_{t-1} + \upsilon_j - \kappa_i), \qquad (20)$$

where,

- Pr denotes probability,
- $OrderedMaturityD^*$ is the unobserved (latent) index function,
- $OrderedMaturityD$ is the ordered maturity debt dependent variable, constructed in section 3.2.1,

[18]We estimate the implied cost of debt by using Equation (1) the Black and Scholes (1973) option pricing model. To calculate the implied cost of debt we need the face value of debt (B), value of equity (V_t), volatility, risk free rate (r) and time to maturity ($T - t$) to find the value of debt in Equation (7). First, we use the mean of empirical $dlc + dltt$ (Compustat items) as the face value (or exercise price) and the mean of empirical market value of assets as the value of equity. Second, we use the empirical estimate for each of the twenty quantiles as the volatility parameter in Equation (1). Third, we parameterize the other variables in Equation (1) and then using Equation (8) find the implied cost of debt in each quantile. The implied cost of debt increases as cash flow volatility increases.

- Φ is the Cumulative Distribution Function (CDF) of the standard normal distribution,
- $X_{i,t-1}$ is a matrix of lagged control variables listed in Section 3.2.2,
- $LnCFV_{i,t-1}$ is $LnCFV$,
- residual υ_j has the standard normal distribution N(0,1), and
- κ is a set of cutpoints, where i is the number of possible outcomes.

insert Table 9

Table 9 reports estimation results of an ordered probit model using $LnCFV$. The positive coefficients of $LnCFV$ suggest that when cash flow volatility increases, the probability that firms hold longer maturity debt decreases i.e. the sample firms are more likely to hold debt with shorter maturities or not holding debt.

insert Table 10

In the ordered probit model, we just interpret the signs but not the magnitude. To show the magnitude of the effect we find the marginal effects.[19] Table 10 reports the marginal effects of $LnCFV$ on each category of the $OrderedMaturityD$. The Table reports that if $LnCFV$ increases by one percent standard deviation, the sample firms are about 0.00266 percent less likely to be in the first category, 0.00648 percent less likely to be in the second category, 0.00471 percent more likely to be in the third category, 0.00193 percent more likely to be in the fourth category and 0.00410 percent more likely to be in the fifth category of the $OrderedMaturityD$ which is the zero long and short-term debt category. Section 3.2.1 defines the five categories of $OrderedMaturityD$.

5 Robustness

In this section we perform robustness analysis to show our result consistency while adopting our model to several benchmarks.

[19]In ordered probit model the marginal effects or the changes in probabilities are a function of two things. First, like the probit model marginal effects in Footnote 17 it depends on the particular value of the X variables and $LnCFV$ variable. Second, the value of $OrderedMaturityD$ which sets as $i = 1$ to 5 by the definition of $OrderedMaturityD$. We find $\frac{\partial(OrderedMaturityD_j=i)}{\partial(LnCFV)}$ for $i = 1$ to 5 at the mean of all explanatory variables.

5.1 Hypothesis 1 Robustness

To test Hypothesis 1 we follow Frank and Goyal (2009) and estimate Equation (17). Unlike Frank and Goyal (2009) there are number of studies that use the lag of dependent variable as an explanatory factor. For the first hypothesis robustness check we follow Flannery and Rangan (2006) and Lemmon et al. (2008) and add the lag of dependent variable to the explanatory factors of Equation (17) as bellow

$$E(DebtRatio_{i,t}|x) = G(\alpha + \beta_1 DebtRatio_{i,t-1} + X_{i,t-1}\beta_2 + \beta_3 LnCFV_{i,t-1}) \tag{21}$$

where $DebtRatio_{i,t-1}$ is the first lag of the dependent variable.

insert Table 11

insert Figure 5

Tables 11 shows that although the coefficients of the lagged dependent variable are highly economically and statistically significant, we still get negative and statistically significant correlation between cash flow volatility and capital structure. In addition, comparing Figures 5 and 2 shows that $MDR3hatGRo$ is a better prediction that $MDR3hatG$ than $MDR3$.

insert Table 12

Table 12 shows the estimation results using a tobit model to test Hypothesis 1. The negative and statistically significant coefficients of $LnCFV$ support the negative effect of cash flow volatility on debt ratios.

5.2 Hypothesis 2 Robustness

Hypothesis 2 finding shows that the probability of a firm being zero leverage increases with higher cash flow volatility. This is not consistent with Strebulaev and Yang (2013) findings. Strebulaev and Yang (2013) test their hypothesis on three categories of their sample. First they use the entire sample of the firms and find an inverse relationship between earnings volatility and zero leverage policy. Then they test their hypothesis on two sub samples including dividend paying and non-dividend paying firms. Strebulaev and Yang (2013) find an inverse relationship for the zero-dividend firms and a positive relationship between earnings volatility and dividend paying firms. Their findings are not consistent for different groups of firms. They also use an almost zero leverage variable and define it as an observation that has book leverage less than 5%. To perform a robustness analysis on Hypothesis 2, we follow Strebulaev and Yang (2013) and categorize our sample as all firms, dividend paying firms and zero-dividend paying firms. We also use the almost zero leverage variable instead of $ZeroLSD$ and $ZeroLTD$.

insert Table 13

Table 13 shows estimation results of a probit model using AZL. Column (1) shows estimation results using all the sample firms. Column (2) show estimation results using the dividend paying (DP) firms. Column (3) shows estimation results using the zero dividend (ZD) firms. Table **??** reports that all the cash flow volatility coefficients are statistically significant and positive, indicating that the probability of being zero-leverage increases with cash flow volatility in all three categories; all firms, dividend paying firms and zero dividend firms. Although we use the same dependent variable AZL and the same categories of sample firms as Strebulaev and Yang (2013), our findings are not consistent with Strebulaev and Yang (2013) findings and consistent with our result in Table 13.

6 Conclusion

The seminal and widely cited paper by Frank and Goyal (2009) does not find volatility as reliable factor for explaining capital structure. In this paper, we investigate the relationship between capital structure and cash flow volatility by using conditional cash flow volatility measure of De Veirman and Levin (2011) used by De Veirman and Levin (2012) and Keefe and Tate (2013). Besides, by considering the Welch (2011) critique, we employ six different market and book debt ratios as our study dependent variable. We test three hypotheses and our results are listed as follow; first, contrary to Frank and Goyal (2009), we find that the relationship between cash flow volatility and capital structure is negative and statistically significant. Second, we use a probit model for two zero-leverage dependent variables to test the effects of cash flow volatility on zero-leverage policy. Unlike Strebulaev and Yang (2013), our positive and statistically significant coefficients show that firms with high cash flow volatility are more likely to follow zero leverage policy. Third, using a categorical dependent variable and the ordered pobit model, we test the effects of cash flow volatility on debt maturity. We find that as cash flow volatility increases, the probability that a firm holds longer maturity debt decreases. This is consistent with Kane et al. (1985) and Stohs and Mauer (1996) who find an inverse relationship between debt maturity and volatility of firm asset value.

A Variable Definitions

Table 1: Variable Definitions
This table provides variable definitions. Column (1) provides the variable name. Column (2) defines the variable. Column (3) shows the variable construction using system variable names. Column (4) provides the data source.

Variable	Definition	Construction	Data Sources
$MDR_{i,t}$	The ratio of (long-term-debt+short-term-debt) to [(long-term-debt+ short-term-debt) + preffered stock + market value of common stock] of firm i at year t (Welch, 2011).	(dltt+dlc)/ (dltt+dlc+pstkl+ csho*prcc_f)	Compustat
$BDR_{i,t}$	The ratio of total assets minus book equity to total assets of firm i at year t Fama and French (2002).	(at-BE[20])/at	Compustat
$LnCFVna_{i,t}$	Natural logarithm of 1 + assets scaled Conditional Cash Flow Volatility according to De Veirman and Levin (2011) model, for firm i at time t.	Appendix (**??**)	Compustat
$LnCFVrev_{i,t}$	Natural logarithm of 1 + revenue scaled Conditional Cash Flow Volatility according to De Veirman and Levin (2011) model, for firm i at time t.	Appendix (**??**)	Compustat
$Tangibility_{i,t}$	The assets tangibility of firm i at year t is the ratio of(ppent) net property, plant, and equipment(at) toatal assets. (Lemmon et al., 2008) and (Frank and Goyal, 2009).	ppenb/at	Compustat
$IndustLev_{i,t}$	The median industry leverage of the sector which the firm i at time t is classified by four-digit SIC code (Frank and Goyal, 2009).	The median of [LT/MVA] [21]	Compustat
$FirmSize_{i,t}$	The proxy for firm i at year t size.	ln(at)	Compustat
$Profitability_{i,t}$	Shows the profitability of firm i at year t.	oibdp/at	Compustat
$MarketToBook_{i,t}$	The proxy for firm i at year t growth opportunities and is the ratio of market value of asset to total assets.	MVA/at	Compustat

[20] Book Equity (BE)= total assets- liabilities+ balance sheet deferred taxes and investment tax credit- preferred stock= at-lt+txditc-pstkl

[21] Market value of assets (MVA) = debt in current liabilities (dlc) + long-term debt (dltt) + preferred stock (pstkl) + market value of equity (csho * prcc-f) - balance sheet deferred taxes and investment tax credit (txditc).

Variable	Definition	Construction	Data Sources
$ExpectedInflation_{i,t}$	The expected change in the consumer price index over the coming year (Frank and Goyal, 2009).		Compustat
$LnRnD_{i,t}$	The ratio of R&D expenses to sale of firm i at year t (Frank and Goyal, 2009).	ln(1+[xrd/revt])	Compustat
$EquIssue_{i,t}$	The split-adjusted change in shares outstanding times the split-adjusted average stock price dividend by the end of year t-1 total assets (Lemmon et al., 2008).	[22]	Compustat
$CreditRating_{i,t}$	Indicator variable: One for firm i if it is listed as investment grade by S&P in year t, and zero otherwise.	=1 if SPLTICRM or SPSDRM $<$ 13	Compustat
$FirmAge_{i,t}$	The number of years firm i has had data in Compustat	fyear-First year in Compustat	Compustat
$ZeroLSD$	Indicator variable set to one if long-term debt plus short-term debt is zero and zero, otherwise	=1 if (dltt+dlc)=0	Compustat
$ZeroLTD$	Indicator variable set to one if long-term debt is zero and zero, otherwise	=1 if (dltt)=0	Compustat
$OrderedMaturityD$	An ordered categorical variable based on debt maturity	Section 3.2.1 defines the five categories of $OrderedMaturityD$	Compustat

[22] $EquIssue_{i,t}$=$[(\text{csho}_t - csho_{t-1}) * (adjexf_{t-1}/adjexf_t)] * [(prccf_t - prccf_{t-1}) * (adjexf_t/adjexf_{t-1})]/at$

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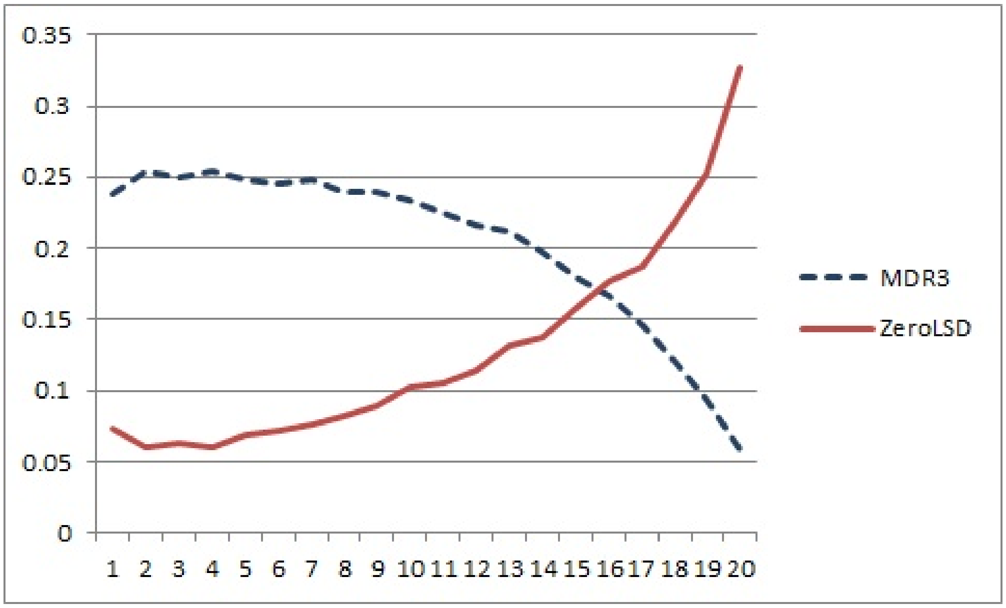

Figure 1: Horizontal axis shows the 20-Quantiles of $LnCFV$. Vertical axis plots the mean of $MDR3$ and $ZeroLSD$ in each quantile.

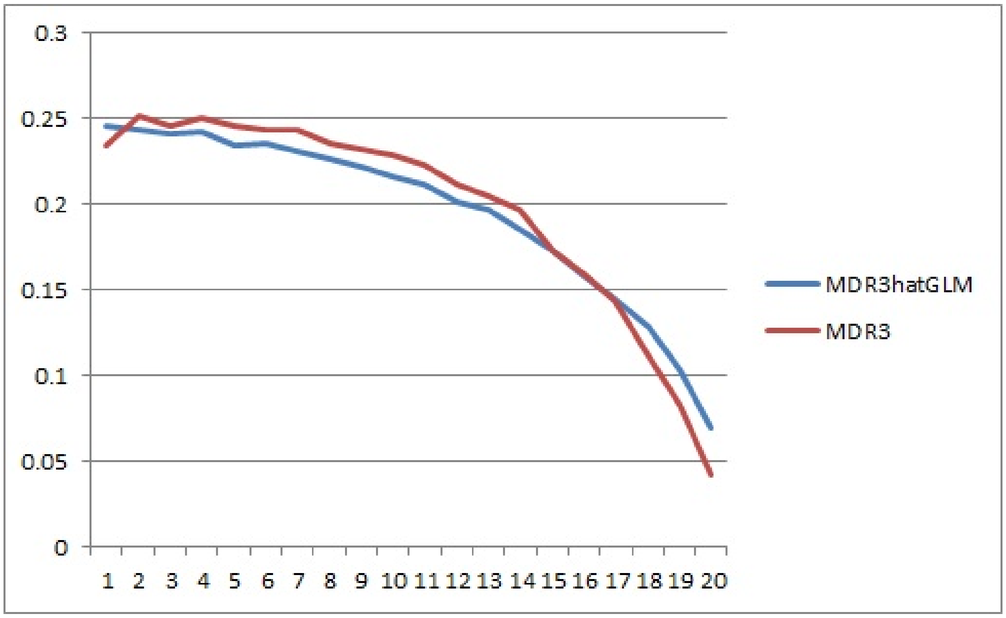

Figure 2: Horizontal axis shows the 20-Quantiles of $LnCFV$. Vertical axis plots the mean of MDR3 and the mean of predicted MDR3 (MDR3hatG) by generalized linear model (GLM) with logit link function Equation (17) in each quantile.

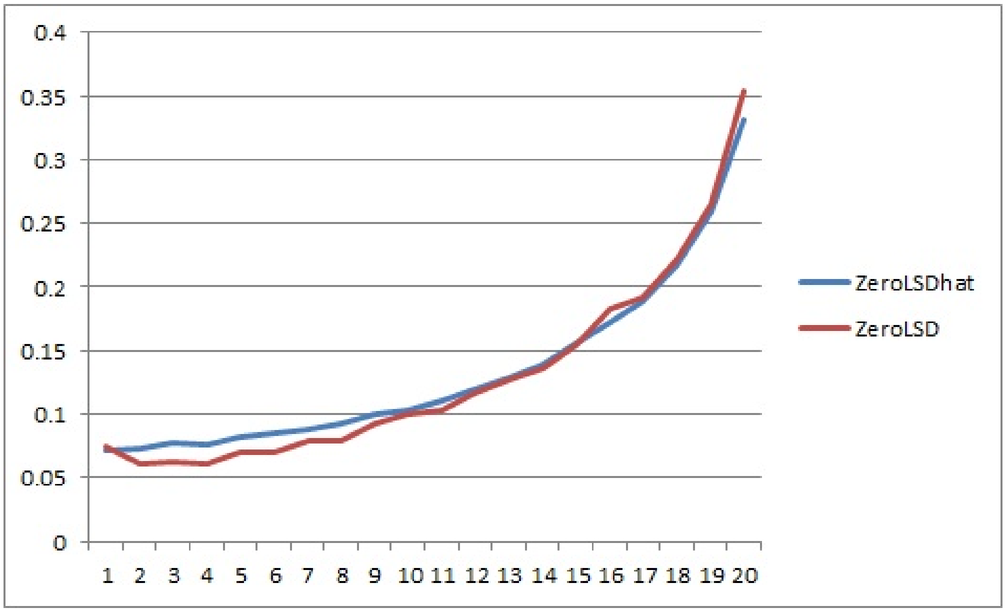

Figure 3: Horizontal axis shows the 20-Quantiles of $LnCFV$. Vertical axis plots the mean of ZeroLSD and predicted ZeroLSD (ZeroLSDhat) by probit model Equation (18) in each quantile.

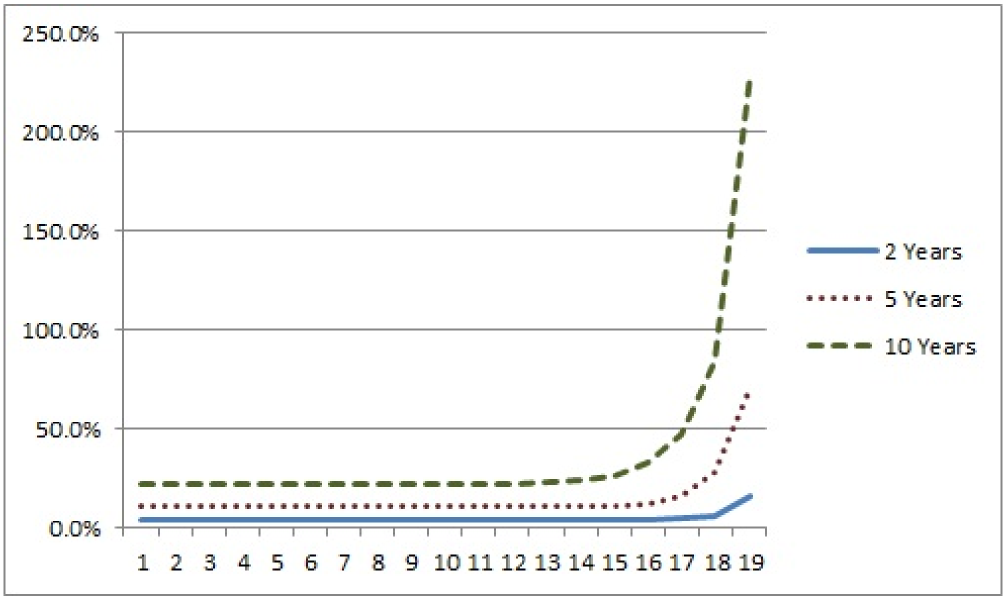

Figure 4: Horizontal axis shows the 20-Quantiles of $LnCFV$. Vertical axis plots the mean of implied cost of debt for different time horizons in each quantile. The solid line, the dotted line and the broken line in the Figure represent the path taken by the mean of implied cost of debt with 2 years, 5 years and 10 years to maturity, respectively. To calculate the implied cost of debt, I used the mean of empirical $dlc + dltt$ (Compustat items) as the value of debt and the mean of empirical market value of assets as the value of equity, we also used the 20-quantiles empirical cash flow volatility as the volatility input of Black and Scholes (1973) Equation (1) and then by using Equation (8) we find the implied cost of debt in each quantile.

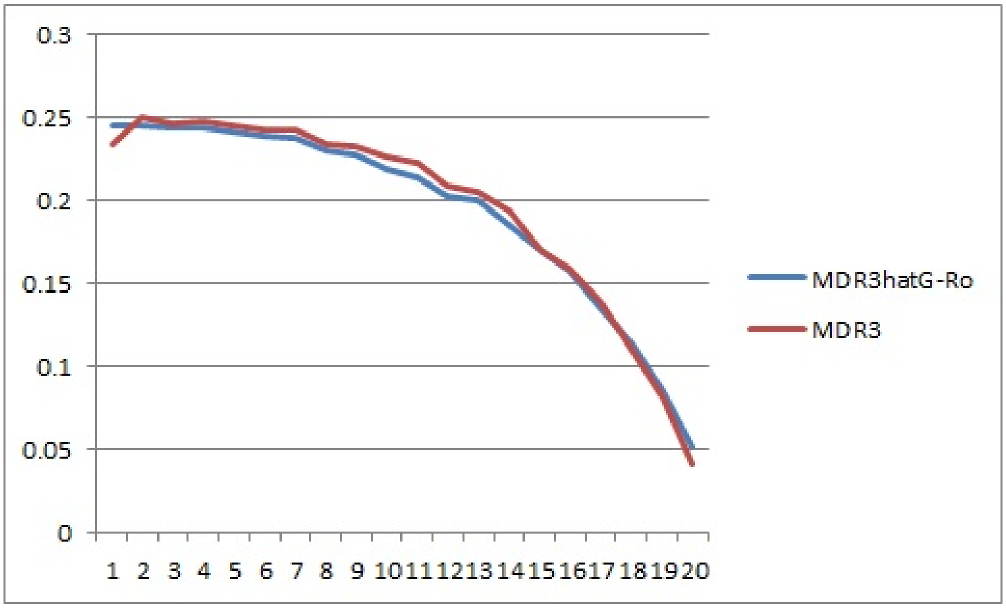

Figure 5: Horizontal axis shows the 20-Quantiles of $LnCFV$. Vertical axis plots the mean of MDR3 and the mean of predicted MDR3 (MDR3hatG-Ro) by generalized linear model (GLM) with logit link function Equation (21) in each quantile.

Table 2: Cash Flow Volatility Skewness and Kurtosis

Variables	Skewness	Kurtosis
CFVna	3.54	16.56
LnCFV	-0.62	4.31

Table 3: Summary Statistics

This table shows summary statistics of variables of the study for non-financial and non-utility US companies during 1974-2012. All the variables are winsorized at 1% level in both tails of the distribution before the summary statistics are calculated. The table reports the number of observations, mean, 25th percentile, median, 75th percentile and standard deviation. Appendix A defines the variables.

variable	N	mean	p25	p50	p75	sd
MDR1	123258	0.376	0.172	0.349	0.556	0.238
BDR1	123258	0.469	0.307	0.475	0.621	0.212
MDR2	123258	0.242	0.0278	0.174	0.395	0.238
BDR2	123258	0.297	0.0621	0.273	0.469	0.247
MDR3	123258	0.197	0.00609	0.118	0.322	0.219
BDR3	123258	0.242	0.0142	0.193	0.397	0.235
ZeroLSD	123258	0.131	0	0	0	0.337
ZeroLTD	123258	0.162	0	0	0	0.369
ASTNG	123154	0.284	0.114	0.233	0.398	0.216
SIZE	123258	4.700	3.238	4.553	6.041	2.023
Age	123258	10.45	4	8	15	8.656
PROF	123258	0.0783	0.0435	0.118	0.179	0.195
MtB	119451	1.513	0.700	1.019	1.693	1.468
EquIss	123255	0.474	0	0.00881	0.143	2.538
IndustLev	123258	0.355	0.238	0.352	0.463	0.141
ln RnD	122902	0.0747	0	0.000145	0.0458	0.237
LnCFV	123258	1.425	0.518	1.501	2.479	1.646
Inflation	123258	0.0439	0.0238	0.0338	0.0560	0.0247
CreditRating	123258	0.0683	0	0	0	0.252

Table 4: Summary of *OrderedMaturityD*

This table shows summary of *OrderedMaturityD* for non-financial and non-utility US companies during 1974-2012. The table reports the number of observations, the frequency and the percentage of the sample firms existing in the each category of *OrderedMaturityD*. Appendix A defines the variables.

Category	Description	Freq.	Percent	Cum.
1	Debt maturity more than ten years	21,930	17.79	17.79
2	No debt that matures in more than ten years	54,104	43.89	61.69
3	No debt that matures in five years or more	24,652	20	81.69
4	Zero total long term debt	6,483	5.260	86.95
5	Zero long-term and short-term debt	16,089	13.1	100
Total		123,258	100	

Table 5: Correlations

This table shows the pairwise correlations between explanatory variables. Appendix A defines the variables. Reference numbers in columns and rows refer to the variables associated with the pairwise correlation.

Pairwise Correlations Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Tangibility	1										
(2) FirmSize	0.127	1									
(3) FirmAge	0.00680	0.405	1								
(4) Profitability	0.182	0.328	0.138	1							
(5) MarketToBook	-0.149	-0.130	-0.0986	-0.214	1						
(6) EquIssue	-0.0442	0.0551	-0.0640	-0.0412	0.309	1					
(7) IndustLev	0.270	0.173	0.0836	0.237	-0.362	-0.103	1				
(8) LnRnD	-0.197	-0.129	-0.106	-0.574	0.351	0.115	-0.381	1			
(9) Inflation	0.152	-0.226	-0.299	0.178	-0.179	-0.0503	0.219	-0.156	1		
(10) CreditRating	0.0723	0.472	0.341	0.109	-0.00720	-0.00370	0.0708	-0.0566	-0.139	1	
(11) LnCFV	-0.164	-0.286	-0.131	-0.330	0.267	0.0894	-0.295	0.290	-0.160	-0.154	1

Table 6: Testing Hypothesis 1 - The effects of cash flow volatility on capital structure

This table shows estimation results of Equation (17) using GLM with logit link function and $LnCFV$. All the RHS variables are in information set and are used in lagged form. Columns (1) to (6) show estimation results using the different capital structure measures as the dependent variable and asset scaled cash flow volatility as the variable of interest. Appendix A defines the variables. The clustered standard errors by firm are shown in parentheses with 1%, 5% and 10% significance level denoted by ***, ** and *, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	MDR1	BDR1	MDR2	BDR2	MDR3	BDR3
LLnCFV	-0.0233***	-0.0152***	-0.0370***	-0.0292***	-0.0432***	-0.0343***
	(0.00262)	(0.00272)	(0.00382)	(0.00383)	(0.00407)	(0.00408)
LTangibility	0.217***	0.299***	0.794***	0.948***	1.102***	1.243***
	(0.0280)	(0.0306)	(0.0409)	(0.0412)	(0.0440)	(0.0440)
LFirmSize	0.0639***	0.0863***	0.0625***	0.0774***	0.119***	0.136***
	(0.00369)	(0.00401)	(0.00556)	(0.00568)	(0.00596)	(0.00604)
LFirmAge	-0.00700***	-0.00407***	-0.0135***	-0.00913***	-0.0134***	-0.00902***
	(0.000759)	(0.000843)	(0.00117)	(0.00121)	(0.00124)	(0.00128)
LProfitability	-1.348***	-1.168***	-1.515***	-1.407***	-1.222***	-1.111***
	(0.0374)	(0.0352)	(0.0546)	(0.0507)	(0.0589)	(0.0550)
LMarketToBook	-0.507***	-0.0770***	-0.568***	-0.114***	-0.571***	-0.113***
	(0.00659)	(0.00416)	(0.0102)	(0.00668)	(0.0116)	(0.00754)
LLnRnD	-0.878***	-0.617***	-1.393***	-0.822***	-1.160***	-0.606***
	(0.0422)	(0.0333)	(0.115)	(0.0673)	(0.132)	(0.0752)
LEquIssue	-0.000113	-0.00458***	-0.00355*	-0.00399**	-0.00434**	-0.00331*
	(0.00132)	(0.00117)	(0.00185)	(0.00176)	(0.00200)	(0.00193)
LIndustLev	1.832***	1.346***	2.262***	1.853***	2.244***	1.823***
	(0.0517)	(0.0536)	(0.0813)	(0.0781)	(0.0878)	(0.0838)
LInflation	3.933***	2.070***	3.843***	2.467***	4.163***	2.501***
	(0.219)	(0.227)	(0.311)	(0.316)	(0.334)	(0.340)
LCreditRating	-0.0822***	0.219***	-0.114***	0.247***	-0.227***	0.104***
	(0.0197)	(0.0242)	(0.0309)	(0.0336)	(0.0315)	(0.0340)
Constant	-0.767***	-0.880***	-1.636***	-1.866***	-2.331***	-2.554***
	(0.0329)	(0.0322)	(0.0504)	(0.0468)	(0.0548)	(0.0507)
Observations	104,347	104,347	104,347	104,347	104,347	104,347

Table 7: Testing Hypothesis 2 - The effect of cash flow volatility on zero-leverage policy

This table shows estimation results of a probit model using zero-leverage dummy dependent variables $ZeroLSD$, $ZeroLTD$ and $LnCFV$. Column (1) shows estimation results using $ZeroLSD$ and Column (2) shows estimation results using $ZeroLTD$. Appendix A defines the variables. Clustered tandard errors are shown in parentheses with 1%, 5% and 10% significance level denoted by ***, ** and *, respectively.

	(1)	(2)
VARIABLES	ZeroLSD	ZeroLTD
LLnCFV	0.0833***	0.0753***
	(0.00627)	(0.00593)
LTangibility	-1.437***	-1.431***
	(0.0818)	(0.0788)
LFirmSize	-0.113***	-0.131***
	(0.00877)	(0.00858)
LFirmAge	0.00554***	0.00414**
	(0.00183)	(0.00174)
LProfitability	0.910***	0.689***
	(0.0629)	(0.0589)
LMarketToBook	0.0783***	0.0778***
	(0.00675)	(0.00673)
LLnRnD	0.286***	0.154***
	(0.0449)	(0.0437)
LEquIssue	-0.00934***	-0.00925***
	(0.00219)	(0.00207)
LIndustLev	-1.312***	-1.196***
	(0.116)	(0.108)
LInflation	-10.57***	-9.773***
	(0.740)	(0.675)
LCreditRating	-1.138***	-1.090***
	(0.143)	(0.119)
Constant	0.169**	0.395***
	(0.0739)	(0.0693)
Observations	104,347	104,347

Table 8: Testing Hypothesis 2, Marginal Effects - The effect of cash flow volatility on zero-leverage policy
This table shows the marginal effects of $LnCFV$ on zero leverage dependent variables $ZeroLSD$ and $ZeroLTD$. As discussed in Footnote 17, to find the marginal effects, we use the mean of all explanatory factors $X_{i,t-1}$ along with the mean, the 25th percentile, and the 75th percentile of our variable of interest $LnCFV$. Columns (1), (2) and (3) show the marginal effects of $LnCFV$ on dependent variable using the 25th percentile, the mean and the 75th percentile of our variable of interest $LnCFV$, respectively. Appendix A defines the variables. Clustered standard errors are shown in parentheses with 1%, 5% and 10% significance level denoted by ***, ** and *, respectively.

Marginal Effects	$\frac{\partial P}{\partial LnCFV}$	(1)	(2)	(3)
VARIABLES	Description	$25th$	$mean$	$75th$
Pr(ZeroLSD)	Firms with zero long and short term debt	0.0113***	0.0126***	0.0141***
		(0.000790)	(0.000975)	(0.00119)
Pr(ZeroLTD)	Firms with zero long term debt	0.0139***	0.0151***	0.0165***
		(0.000985)	(0.00117)	(0.00138)
Observations		104,347	104,347	104,347

Table 9: Testing Hypothesis 3 - The effects of cash flow volatility on maturity of debt

This table shows estimation results of an ordered probit model to test a categorical dependent variable. The first category includes firms that hold debt with more than ten years of maturity, and the last category includes firms with no long and short-term debt. Table 4 describe the *OrderedMaturityD* categorical variable. Appendix A defines the variables. Standard errors are shown in parentheses with 1%, 5% and 10% significance level denoted by ***, ** and *, respectively.

VARIABLES	OrderedMaturityD
LLnCFV	0.0375***
	(0.00379)
LTangibility	-1.750***
	(0.0729)
LFirmSize	-0.195***
	(0.0108)
LFirmAge	0.0273***
	(0.00211)
LProfitability	0.309***
	(0.0529)
LMarketToBook	0.0429***
	(0.00624)
LLnRnD	0.280***
	(0.0512)
LEquIssue	-0.00316*
	(0.00174)
LIndustLev	-2.742***
	(0.115)
LInflation	-4.917***
	(0.432)
LCreditRating	-0.601***
	(0.0665)
Constant	-4.062***
	(0.0753)
Constant	-1.787***
	(0.0657)
Constant	-0.681***
	(0.0640)
Constant	-0.285***
	(0.0636)
Constant	1.727***
	(0.0456)
Observations	104,347
Number of permno	11,524

Table 10: Testing Hypothesis 3, Marginal Effects - The effects of cash flow volatility on maturity of debt
This table shows the marginal effects of $LnCFV$ on each category of $OrderedMaturityD$ categorical variable using an ordered probit model. Using the mean of explanatory variable, the table shows the marginal effects of $LnCFV$ in five categories of ordinal $OrderedMaturityD$. Appendix A defines the variables. Standard errors are shown in parentheses with 1%, 5% and 10% significance level denoted by ***, ** and *, respectively.

OrderedMaturityD	Description	$\frac{\partial P}{\partial LnCFV}$
1	Debt maturity more than ten years	-0.00266***
		(0.000307)
2	No debt that matures in more than ten years	-0.00648***
		(0.000664)
3	No debt that matures in five years or more	0.00471***
		(0.000486)
4	Zero total long term debt	0.00193***
		(0.000199)
5	Zero long-term and short-term debt	0.00410***
		(0.000428)
Observations		104,347

Table 11: Hypothesis 1 First Robustness check - Adding the lag of capital structure measures to the RHS

This table shows estimation results of Equations (21) using GLM with logit link function. The first lag of dependent variable is added to RHS. Columns (1) to (6) show estimation results using the different capital structure measures as the dependent variable and total asset scaled cash flow volatility as the variable of interest. Appendix A defines the variables. The clustered standard errors by firm are shown in parentheses with 1%, 5% and 10% significance level denoted by ***, ** and *, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	MDR1	BDR1	MDR2	BDR2	MDR3	BDR3
L.MDR1	3.639***					
	(0.0160)					
L.BDR1		3.781***				
		(0.0144)				
L.MDR2			4.366***			
			(0.0207)			
L.BDR2				4.498***		
				(0.0194)		
L.MDR3					4.486***	
					(0.0245)	
L.BDR3						4.619***
						(0.0221)
LLnCFV	-0.00224	-0.00332***	-0.0104***	-0.0151***	-0.0141***	-0.0189***
	(0.00149)	(0.00117)	(0.00224)	(0.00199)	(0.00246)	(0.00224)
LTangibility	0.0795***	0.0684***	0.315***	0.264***	0.408***	0.340***
	(0.0101)	(0.00821)	(0.0148)	(0.0127)	(0.0172)	(0.0152)
LFirmSize	0.0183***	0.0146***	0.0143***	0.00956***	0.0367***	0.0285***
	(0.00134)	(0.00108)	(0.00208)	(0.00185)	(0.00239)	(0.00219)
LFirmAge	-0.00379***	-0.00277***	-0.00472***	-0.00285***	-0.00408***	-0.00238***
	(0.000276)	(0.000217)	(0.000474)	(0.000404)	(0.000534)	(0.000465)
LProfitability	-0.322***	-0.380***	-0.257***	-0.402***	-0.106***	-0.306***
	(0.0213)	(0.0177)	(0.0325)	(0.0317)	(0.0384)	(0.0374)
LMarketToBook	-0.0710***	-0.0206***	-0.108***	-0.0356***	-0.140***	-0.0420***
	(0.00327)	(0.00197)	(0.00498)	(0.00393)	(0.00587)	(0.00468)
LLnRnD	-0.402***	-0.119***	-0.598***	-0.215***	-0.552***	-0.196***
	(0.0230)	(0.0158)	(0.0569)	(0.0328)	(0.0725)	(0.0400)
LEquIssue	0.00342***	0.00266***	0.00498***	0.00298**	0.00554***	0.00331**
	(0.00101)	(0.000818)	(0.00145)	(0.00139)	(0.00158)	(0.00161)
LIndustLev	0.492***	0.208***	0.602***	0.371***	0.663***	0.446***
	(0.0193)	(0.0144)	(0.0302)	(0.0249)	(0.0354)	(0.0293)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	MDR1	BDR1	MDR2	BDR2	MDR3	BDR3
LInflation	-0.224***	-0.210***	-0.176	0.835***	0.754***	1.808***
	(0.0849)	(0.0645)	(0.124)	(0.106)	(0.138)	(0.120)
LCreditRating	-0.000613	0.0446***	0.0890***	0.145***	0.0686***	0.136***
	(0.00721)	(0.00585)	(0.0117)	(0.00957)	(0.0131)	(0.0109)
Constant	-2.016***	-1.933***	-2.567***	-2.529***	-2.899***	-2.846***
	(0.0135)	(0.0110)	(0.0209)	(0.0184)	(0.0241)	(0.0212)
Observations	104,347	104,347	104,347	104,347	104,347	104,347

Table 12: Hypothesis 1 Second Robustness check
This table shows estimation results of a tobit model to test the first hypothesis. Columns (1) to (6) show estimation results using the *LnCFV* as different market and book debt ratios explanatory variables. Appendix A defines the variables. Standard errors are shown in parentheses with 1%, 5% and 10% significance level denoted by ***, ** and *, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	MDR1	BDR1	MDR2	BDR2	MDR3	BDR3
LLnCFV	-0.00601***	-0.00361***	-0.00935***	-0.00785***	-0.00991***	-0.00874***
	(0.000600)	(0.000652)	(0.000761)	(0.000865)	(0.000739)	(0.000850)
LTangibility	0.0420***	0.0726***	0.168***	0.233***	0.217***	0.286***
	(0.00670)	(0.00743)	(0.00862)	(0.00972)	(0.00865)	(0.00982)
LFirmSize	0.0146***	0.0209***	0.0144***	0.0183***	0.0238***	0.0292***
	(0.000839)	(0.000959)	(0.00110)	(0.00128)	(0.00108)	(0.00125)
LFirmAge	-0.00124***	-0.000960***	-0.00225***	-0.00201***	-0.00203***	-0.00181***
	(0.000176)	(0.000203)	(0.000228)	(0.000272)	(0.000218)	(0.000264)
LProfitability	-0.295***	-0.276***	-0.286***	-0.297***	-0.222***	-0.211***
	(0.00755)	(0.00816)	(0.00925)	(0.0109)	(0.00881)	(0.0106)
LMarketToBook	-0.0608***	-0.0173***	-0.0478***	-0.0219***	-0.0397***	-0.0193***
	(0.000898)	(0.000909)	(0.00108)	(0.00123)	(0.00107)	(0.00122)
LLnRnD	-0.120***	-0.137***	-0.114***	-0.139***	-0.0721***	-0.0851***
	(0.00541)	(0.00671)	(0.00754)	(0.00990)	(0.00720)	(0.00963)
LEquIssue	0.000661***	-0.00100***	0.000494*	-0.000196	0.000243	-6.29e-05
	(0.000245)	(0.000267)	(0.000282)	(0.000351)	(0.000274)	(0.000350)
LIndustLev	0.477***	0.331***	0.502***	0.422***	0.449***	0.382***
	(0.0118)	(0.0128)	(0.0154)	(0.0173)	(0.0150)	(0.0170)
LInflation	1.174***	0.510***	1.227***	0.725***	1.260***	0.762***
	(0.0531)	(0.0551)	(0.0669)	(0.0730)	(0.0659)	(0.0724)
LCreditRating	-0.0311***	0.0518***	-0.0245***	0.0616***	-0.0405***	0.0325***
	(0.00486)	(0.00577)	(0.00611)	(0.00779)	(0.00581)	(0.00748)
Constant	0.225***	0.185***	0.0160*	0.0375***	0.208***	0.238***
	(0.00704)	(0.00760)	(0.00118)	(0.00133)	(0.00125)	(0.00979)
Constant	0.179***	0.281***	0.216***	0.243***	-0.0992***	-0.0946***
	(0.000762)	(0.000887)	(0.00904)	(0.0101)	(0.00868)	(0.00142)
Observations	104,347	104,347	104,347	104,347	104,347	104,347

Table 13: Hypothesis 2 Robustness check - Almost Zero Leverage Probit Model
This table shows estimation results of a probit model using $LnCFV$ and AZL (when the $BDR3$ is less than 5%). Column (1) shows estimation results using all the sample firms. Column (2) shows estimation results using the dividend paying (DP) firms. Column (3) shows estimation results using the zero dividend (ZD) firms. Appendix A defines the variables. Standard errors are shown in parentheses with 1%, 5% and 10% significance level denoted by ***, ** and *, respectively.

	(1)	(2)	(3)
VARIABLES	All	DP	ZD
LLnCFV	0.0766***	0.0799***	0.0842***
	(0.00491)	(0.00913)	(0.00568)
LTangibility	-1.590***	-1.610***	-1.589***
	(0.0608)	(0.132)	(0.0645)
LFirmSize	-0.142***	-0.221***	-0.137***
	(0.00705)	(0.0141)	(0.00797)
LFirmAge	0.00215	0.0120***	-0.00561***
	(0.00142)	(0.00255)	(0.00160)
LProfitability	0.664***	2.014***	0.268***
	(0.0519)	(0.220)	(0.0524)
LMarketToBook	0.110***	0.195***	0.0846***
	(0.00636)	(0.0231)	(0.00619)
LLnRnD	0.187***	1.468***	0.0474
	(0.0440)	(0.508)	(0.0430)
LEquIssue	-0.00215	-0.00411	-0.000735
	(0.00192)	(0.00502)	(0.00209)
LIndustLev	-1.534***	-1.278***	-1.607***
	(0.0913)	(0.196)	(0.0956)
LInflation	-10.10***	-8.249***	-14.75***
	(0.500)	(0.761)	(0.678)
LCreditRating	-0.757***	-0.783***	-0.643***
	(0.0673)	(0.0855)	(0.136)
Constant	1.173***	1.014***	1.412***
	(0.0570)	(0.138)	(0.0651)
Observations	104,347	40,226	64,121